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Cross-sectional estimates of logging equipment resale values

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Abstract

Prices for used logging equipment were collected from various sources and compared with the original sales price based on equipment age, condition, and geographic region. The data were summarized in tabular form and used to estimate means and regression equations for overall salvage value percentages by age of equipment. Age and equipment condition were useful in predicting salvage values, but geographic region was not. Salvage values were generally greater than those that are commonly reported and used in the literature.

Equipment salvage values — the prices that used equipment can be sold for — are often used to estimate machine ownership costs for timber harvesting equipment and trucks. Salvage values of forest harvesting equipment influence many of the purchase/replacement/budgeting decisions made in the logging industry. The salvage or residual value of a piece of equipment, whether at the end of its useful life or at some age before, will affect cash flows, rates of depreciation, maintenance and repair decisions, and new and used machine purchase decisions.

Estimates of machine salvage values have usually relied on rules- of-thumb developed by early harvesting analysts and professors. These estimates often range from 15 to 25 percent of the original sales value of the machine. The values represent a machine's value at the end of its assumed useful life span, generally 3 to 6 years depending on the type of equipment. However, machines often last beyond the expected life or are resold before their assumed life span has ended. Additionally, costs for new equipment have increased substantially in recent years, which may affect salvage values as well. Salvage values also only estimate the value of equipment at the end of an assumed life span. More information on resale values at other times in the life span or by condition of equipment or by geographic region also would be useful. The objective of this study was to provide better information on the resale values of timber harvesting equipment, both at the end of the traditional assumed life span, and in other years previous to that. Accordingly, this study estimated current resale values for logging equipment based on cross-sectional price data gleaned from various sources.

Literature

Most authors have used a constant rule-of-thumb to estimate the salvage value of a piece of equipment, based on its life and original purchase price. Warren (9) and Hypes and Stuart (7) used varying percentage rates for estimating equipment salvage values, which were also relied on by Cubbage (3). Miyata (8) recommended that salvage values should be 20 percent of the initial price. Based on the higher new equipment prices, which seemed to make used equipment more valuable, Werblow and Cubbage (10) recommended that 25 percent be used as an estimate of salvage value.

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TABLE 1. — *Machine life and salvage value estimates.*[a]

Machine category/description	Life	Salvage value[b]
	(yr.)	
Chain saw	1	20
Tree shear, without carrier	5	50
Feller-buncher, small, rubber-tired	3	20
Feller-buncher, medium to large, rubber-tired	4	20
Feller-buncher, large, tracked, boom	5	15
Cable skidder, less than 80 horsepower	4	20
Cable skidder, medium, 80 to 100 horsepower	4	20
Cable skidder, medium, 101 to 120 horsepower	5	15
Cable skidder, more than 120 horsepower	5	10
Grapple skidder, 70 to 90 horsepower	4	20
Grapple skidder, more than 91 horsepower	5	25
Grapple skidder, large, tracked, bunk	5	15
Forwarder, shortwood	4	21
Slasher/loader, multistem	4	20
Delimber, iron gate	5	0
Harvester, combine	4	20
Loader, bigstick	5	10
Loader, small, hydraulic	5	30
Loader, medium, hydraulic	5	30
Chipper, small to medium, 12 to 18 inches	5	20
Chipper, large, over 22 inches	5	20
Crawler tractor, less than 100 horsepower	5	20
Crawler tractor, 101 to 200 horsepower	5	20
Crawler tractor, more than 201 horsepower	5	20

[a] Adapted from Brinker et al. (1).
[b] Percent of purchase price at end of life span.

In 1989, Brinker et al. (1) published a summary table of the typical salvage values and life spans for forest harvesting equipment (Table 1), which were based on the Warren (9), Hypes and Stuart (7), and Cubbage (3) salvage value estimates. But Brinker et al. also relied on an average salvage rate of 20 percent for all their machine rate calculations. None of these authors presented any specific resale data that provided an empirical basis for their salvage value estimates.

Data

Data on used equipment sale prices were obtained from annual summary books published by various equipment cost auction houses and data sources (*Green Guide* 1987-1989 (6), Forke Brothers 1980-1988 (5)). Individual equipment information was recorded concerning the type of machine, used auction sales price, age, equipment options, region of sale, and general condition of equipment for machines 20 years of age and younger. The data were separated into five equipment classes or categories — rubber-tired feller-bunchers, cable skidders, grapple skidders, knuckleboom loaders, and all equipment combined — and sorted by year of manufacture. Information on other

TABLE 2. — *Summary of harvesting equipment salvage value data by equipment class and age.*

Equipment class	Equipment age (yr.)										
	1	2	3	4	5	6	7	8	9	10	11+
Rubber-tired feller-bunchers											
Number of sales	0	0	8	21	10	8	5	8	7	4	4
Percentage of original price											
Mean	NA	NA	0.375	0.278	0.250	0.277	0.265	0.226	0.218	0.309	0.144
Standard deviation	NA	NA	0.103	0.074	0.043	0.073	0.067	0.081	0.149	0.070	0.048
Minimum	NA	NA	0.202	0.158	0.205	0.170	0.188	0.068	0.054	0.188	0.077
Maximum	NA	NA	0.540	0.373	0.355	0.391	0.382	0.335	0.456	0.355	0.201
Cable skidders											
Number of sales	1	2	8	11	9	4	22	18	30	23	55
Percentage of original price											
Mean	0.635	0.508	0.446	0.350	0.281	0.387	0.340	0.280	0.307	0.265	0.352
Standard deviation	NA	0.035	0.059	0.097	0.071	0.115	0.116	0.085	0.098	0.070	0.143
Minimum	NA	0.473	0.342	0.188	0.189	0.224	0.145	0.152	0.083	0.158	0.121
Maximum	NA	0.543	0.496	0.506	0.405	0.551	0.684	0.416	0.618	0.465	0.665
Grapple skidders											
Number of sales	5	9	8	12	23	13	18	23	26	13	27
Percentage of original price											
Mean	0.639	0.463	0.413	0.349	0.282	0.288	0.250	0.242	0.231	0.246	0.283
Standard deviation	0.032	0.143	0.131	0.099	0.093	0.098	0.098	0.098	0.086	0.104	0.088
Minimum	0.577	0.196	0.272	0.149	0.159	0.175	0.111	0.097	0.107	0.131	0.145
Maximum	0.662	0.765	0.702	0.546	0.518	0.497	0.429	0.594	0.407	0.429	0.508
Knuckleboom loaders											
Number of sales	2	3	4	5	4	8	4	12	19	3	9
Percentage of original price											
Mean	0.780	0.563	0.473	0.599	0.465	0.444	0.335	0.321	0.323	0.361	0.357
Standard deviation	0.053	0.071	0.067	0.208	0.150	0.143	0.074	0.148	0.166	0.086	0.145
Minimum	0.726	0.504	0.397	0.306	0.242	0.132	0.261	0.073	0.077	0.327	0.162
Maximum	0.833	0.663	0.559	0.875	0.663	0.650	0.458	0.596	0.701	0.533	0.573
All classes											
Number of sales	8	14	28	49	46	33	49	62	82	43	95
Percentage of original price											
Mean	0.647	0.491	0.420	0.334	0.290	0.323	0.299	0.270	0.227	0.268	0.319
Standard deviation	0.071	0.126	0.104	0.141	0.103	0.136	0.111	0.109	0.125	0.086	0.134
Minimum	0.577	0.196	0.202	0.149	0.159	0.132	0.111	0.068	0.054	0.131	0.077
Maximum	0.833	0.765	0.702	0.875	0.663	0.650	0.684	0.596	0.701	0.465	0.665

TABLE 3. — *Regression equations selected to predict salvage value as a percent of original purchase price by year.*[a]

			Model: salvage % = $\beta_0 + \beta_1(1/age^{0.5}) + \beta_2(condition\ code)$							
			β_1			β_2				
Equipment class/age span	N	β_0	Estimate	Standard error	t value	Estimate	Standard error	t value	r^2	Sy · x
Rubber-tired feller-bunchers										
1 to 5 years	39	–0.199	0.976	0.282	3.45	NA	- -	- -	0.24	0.078
1 to 10 years	71	0.038	0.270	0.133	2.02	0.042	0.014	3.02	0.19	0.088
Cable skidders										
1 to 5 years	31	–0.019	0.737	0.138	5.32	NA	- -	- -	0.49	0.084
1 to 10 years	128	0.056	0.403	0.083	4.66	0.041	0.011	3.91	0.31	0.091
Grapple skidders										
1 to 5 years	56	0.018	0.633	0.090	7.07	NA	- -	- -	0.48	0.109
1 to 10 years	149	–0.051	0.532	0.058	9.09	0.046	0.011	3.88	0.49	0.096
Knuckleboom loaders										
1 to 5 years	18	0.290	0.446	0.228	1.95	NA	- -	- -	0.19	0.161
1 to 10 years	63	0.023	0.685	0.139	4.94	0.035	0.025	1.44	0.33	0.155
All classes										
1 to 5 years	144	–0.013	0.709	0.074	9.52	NA	- -	- -	0.39	0.120
1 to 10 years	411	0.000	0.494	0.047	10.44	0.041	0.008	5.43	0.31	0.114

[a] All regressions are significant at alpha = 0.05. Condition codes are 1 = poor; 2 = fair; 3 = good; 4 = very good; 5 = excellent. NA = not applicable.

classes of equipment such as bulldozers, chippers, slashers, and trucks was not sufficient for analysis.

The *Green Guide* and prior machine rate estimates (2-4,10) provided data on the original sales prices for the make, model, and year of manufacture for each individual piece of equipment. The same sales prices were used in all regions. Machine serial numbers were used when available to substantiate the year of manufacture reported in the auction house reports. Equipment prices included all standard original equipment with additional options noted at the time of resale. Those machines having non-original options or lacking options generally found on original equipment had their original sale value increased or decreased accordingly by the estimated average price of the option in that particular year of manufacture. If older equipment had newer, upgraded options such as a new grapple, winch, or shear, the price of this new equipment was subtracted from the resale price.

Once the original sales price and resale price data had been recorded, the percentage of original cost represented by the salvage value was calculated for each individual machine. This was done individually for all machines (a total of 451 machines) and collectively for all categories of equipment. Salvage percent yearly averages were determined for each machine category for equipment 1 to 10 years of age and for all those machines with an age greater than 10 years.

These percentage resale values were then averaged by class and by year (Table 2). Plots of values versus age were made for each class of equipment and for the combined class data as well. These resale value plots showed the estimated average yearly decline in value of used machinery over a 10-year life span, and provided the basis for further analyses. Equipment more than 10 years old was not included in the final analyses.

Analysis

The equipment sales data were used to estimate average resale values of classes of equipment. Multiple regression was used to examine the effect of three variables — machine age, physical condition at the time of sale, and geographic region where purchased — on average resale value. Age, five states of equipment condition (poor, fair, good, very good, and excellent), and five U.S. regions (Southeast, Northeast, Central, Midwest, West) were examined in linear models. The equipment condition codes are listed in the auction house reporting books. The regions corresponded to those used in most Forest Service timber analyses. These variables were tested alone and in various combinations.

Correlation and regression analyses indicated a very weak relationship between the salvage value percentage and the region of sale for all models, based on use of dummy variables. Region added less than 2 percent to the multiple coefficient of determination (r^2) of the predicted value for all classes of machines.

Machine condition was coded from 1 (poor) to 5 (excellent) for the analyses. The condition variable contributed moderately (up to 11 percentage points) in the two-variable linear model: [*value* = *f* (*age* + *condition*)]. None of these untransformed linear models yielded an r^2 value greater than 0.35. Age was clearly the most significant independent variable affecting salvage values for all equipment classes.

Various data transformations and regression models were examined. The salvage value percentages generally sloped downward rapidly and then leveled off after 5 or 6 years. The transformations and models tested included:

Salvage value % = *age*
Salvage value % = *age* + *condition*
Salvage value % = *age* × *condition*
Salvage value % = ln (*age*)
Salvage value % = 1/*age*

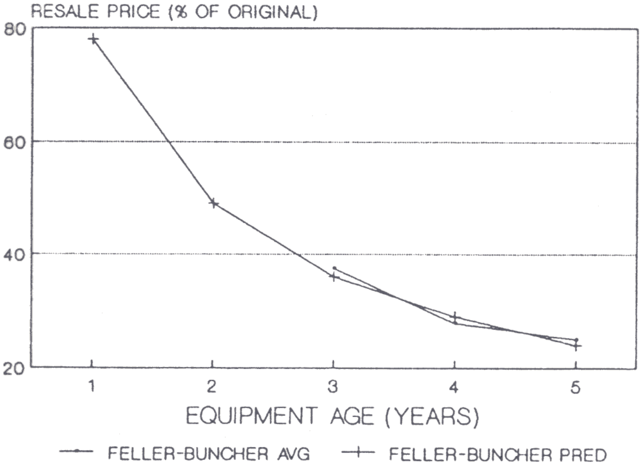

Figure 1. — Actual average versus predicted salvage value percentages for rubber-tired feller-bunchers, equipment ages 1 to 5 years.

Salvage value % = 1/*age*$^{0.5}$
Salvage value % = *age* + *age*^{2}
Salvage value % = 1/*age*$^{0.5}$ + *condition*
(ln)*Salvage value* % = ln (*age*)

The regression analyses generally indicated that the transformation of salvage value percent = 1/age$^{0.5}$ proved most useful in predicting salvage values. Condition code also was useful in some regressions, depending on the number of years for which salvage values were estimated. The coefficients of determination were modest, ranging up to 0.49, but all the prediction equations selected were significant (Table 3) and the predicted salvage values tracked the actual average salvage values (Figs. 1-5).

For equipment that was up to 5 years old, the inverse transformed age variable alone served as the best predictor of the salvage value percentage. The equipment condition code contributed only two or

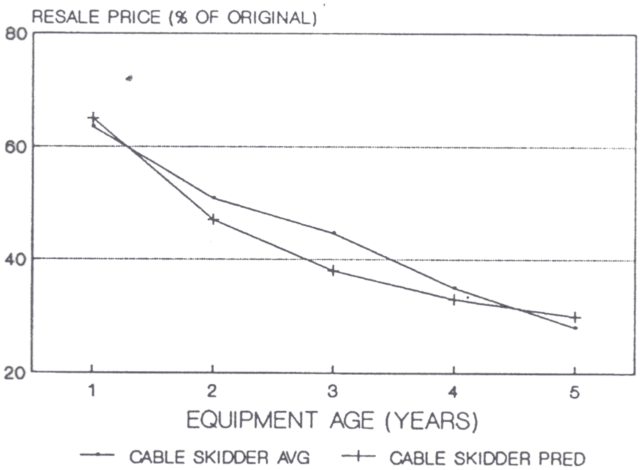

Figure 2. — Actual average versus predicted salvage value percentages for cable skidders, equipment ages 1 to 5 years.

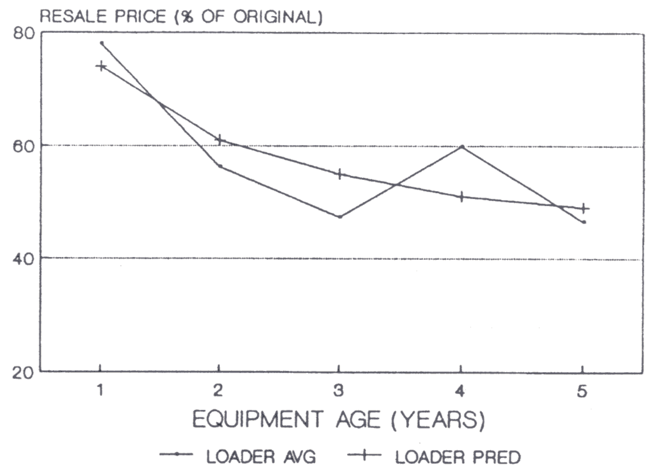

Figure 4. — Actual average versus predicted salvage value percentages for knuckleboom loaders, equipment ages 1 to 5 years.

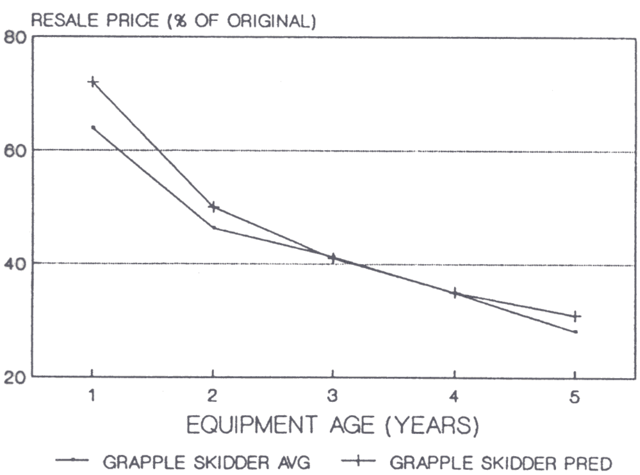

Figure 3. — Actual average versus predicted salvage value percentages for grapple skidders, equipment ages 1 to 5 years.

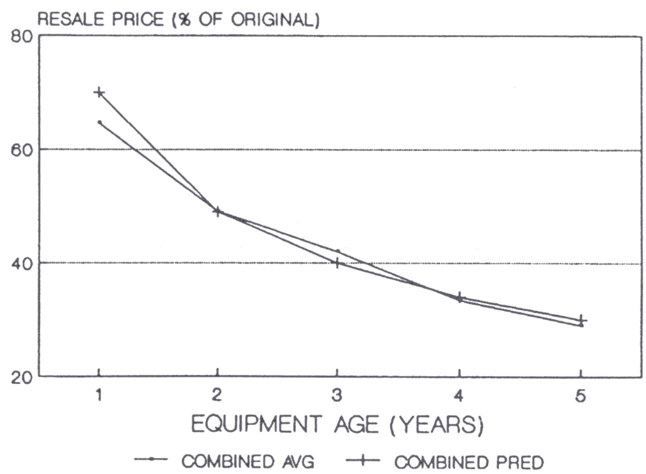

Figure 5. — Actual average versus predicted salvage value percentages for all equipment classes, equipment ages 1 to 5 years.

TABLE 4. — *Selected salvage value percentages by equipment age and source.*

Equipment class	Equipment age (yr.) 1	2	3	4	5	6	7	8	9	10
	(resale value as a percent of original sales price)									
Rubber-tired feller-bunchers										
1 to 5 year regression	78	49	36	29	24	--	--	--	--	--
1 to 10 year regression[a]	43	35	32	30	28	27	27	26	25	25
Rules-of-thumb	--	--	--	20	--	--	--	--	--	--
Cable skidders										
1 to 5 year regression	65	47	38	33	30	--	--	--	--	--
1 to 10 year regression	62	46	39	35	32	30	29	28	26	26
Rules-of-thumb	--	--	--	--	25	--	--	--	--	--
Grapple skidders										
1 to 5 year regression	72	50	41	35	31	--	--	--	--	--
1 to 10 year regression	58	46	41	38	36	34	33	32	31	31
Rules-of-thumb	--	--	--	20	--	--	--	--	--	--
Knuckleboom loaders										
1 to 5 year regression	74	61	55	51	49	--	--	--	--	--
1 to 10 year regression	81	61	52	47	43	41	39	37	36	34
Rules-of-thumb	--	--	--	--	30	--	--	--	--	--
All equipment										
1 to 5 year regression	70	49	40	34	30	--	--	--	--	--
1 to 10 year regression	62	47	41	37	34	32	31	30	29	28
Rules-of-thumb	--	--	--	--	20	--	--	--	--	--

[a] All 1-to-10-year regression percentages were computed using good condition class (code 3).

TABLE 5. — *Average salvage values by equipment age and condition for the combined data set that includes all equipment.*

Condition class	Equipment age (yr.) 1	2	3	4	5	6	7	8	9	10
	(resale value as a percent of original sales price)									
Poor (1)	54	39	33	29	26	24	23	22	21	20
Fair (2)	58	43	37	33	30	28	27	26	25	24
Good (3)	62	47	41	37	34	32	31	30	29	28
Very good (4)	66	51	45	41	38	37	35	34	33	32
Excellent (5)	70	55	49	45	43	41	39	38	37	36

three percentage points to the multiple coefficient of determination for each equipment category, and usually was not statistically significant. For the regressions for equipment ranging from 1 to 10 years old, the addition of equipment condition usually contributed significantly to the salvage value prediction equations. Condition added about 2 to 10 percentage points to the multiple coefficient of determination, depending on the equipment class. No prediction equations proved very worthwhile when equipment older than 10 years was included in the regression models.

Discussion

Cross-sectional data for this analysis of timber harvesting equipment resale values was collected from several sources. The list price for new equipment was compared with the resale price from auction sales to calculate a percentage resale value by equipment age, condition, and region of sale. In practice, buyers may receive some discount from list, and auctioneers charge a fee for their services. These discounts are not consistent, so the stated original purchase and auction prices provide the best means for estimating resale percentage values. Since the discounts tend to reduce prices for both, they should have little effect on average resale percentages.

The results of the data collection and statistical analyses are revealing. It seemed clear that a considerable amount of logging equipment was being used and retaining its value beyond the conventional 4- to 5-year depreciation period. Regression analyses indicated that some types of equipment were more predictable in their decline in value over time than other types. The prediction equations for rubber-tired feller-bunchers and knuckleboom loaders indicated that age and condition explained only about one-fifth to one-third of the variability in resale price. The feller-buncher data had no observations for the first 2 years, which probably contributed to poor estimation. There also are probably more differences in feller-bunchers (such as in the sawhead) than in skidders. Cable skidder and grapple skidder resale price variability was explained better than feller-buncher variability by the regression equations. The skidder data sets also had more observations, which tend to increase coefficients of determination.

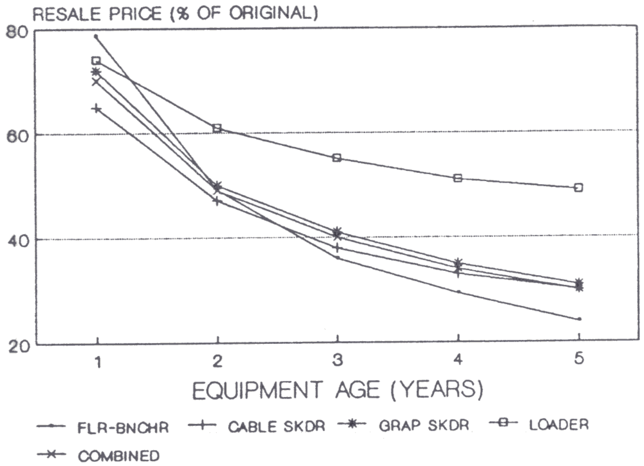

Figure 6. — Predicted equipment salvage values by machine class, for equipment ages 1 to 5 years.

One can use the regression equations shown in Table 3 to compute normal resale values by year, for average condition machines. In Table 4, these computed resale values are compared to the common salvage value rules-of-thumb. These comparisons indicate that used timber harvesting equipment has kept its value considerably better than most rules-of-thumb have assumed. Table 4 also shows that the salvage estimates based on 5- or 10-year-old equipment data sets are reasonably close to each other for the first 5 years. The largest differences occur in the first year, for which there were little data available.

Note that the data in Table 2 indicate that there is a slight jump or smaller drop in salvage values in the sixth year. This may be due to an equipment overhaul after its initial depreciation period has expired. From that point on, the original trend in decreased resale value seems to continue.

One also could compute two-factor tables relating salvage value percentages to age and condition class. Table 5 presents a summary table for the combined equipment class for ages 1 to 10, and very poor (1) to excellent (5) states of condition. The largest drops in value by year occurred in the first through third years, and they tapered off quickly after that. These data also indicate that equipment condition is likely to affect the resale price of older equipment significantly, at about 4 percentage points difference per change in condition class. Most equipment was classified as fair to very good in the auction sale reports, however. This would usually translate into practical differences of only eight percentage points.

The resale value prediction equations calculated predict resale value in nominal terms, and thus include the effect of inflation. The equations were estimated in nominal terms because equipment cash flow analyses often rely on nominal price data, and tax calculations always require nominal prices. Even machine rate calculations (e.g., Miyata's (8)) that are commonly used to estimate equipment costs use a nominal interest rate to calculate the average annual investment (AAI), which implies that purchase and salvage values should be used in nominal terms. These equipment sales occurred during the 1980s, when inflation rates were fairly similar to the modest historical rates, so should be fairly reliable. Much higher than average inflation rates might change these salvage value estimates.

Conclusions

Of the three factors examined that could contribute variability to equipment resale prices, age was by far the most significant. Equipment condition was statistically significant in predicting resale values when the data set included equipment up to 10 years old, but not for the data set of equipment up to 5 years old.

These analyses also indicate that the old rules-of-thumb for equipment salvage values are too conservative now. At the end of their traditional life spans, rubber-tired feller-buncher values were 29 percent rather than 20 percent of the original price; grapple skidder values were 30 percent versus 25 percent; cable skidders were 35 percent versus 20 percent; and knuckleboom loaders were 49 percent versus 30 percent (based on the 5-yr. resale value regression equations). The analysis provides a means to estimate resale values for other years.

Currently, equipment may retain its value better because relatively high new equipment prices have made older equipment more valuable than in the past; or old equipment may last longer than it did decades ago; or it may be maintained better. The moderate inflation rates of the 1980s also may help old equipment retain its nominal value better than the almost nonexistent inflation rates did in the 1940s and 1950s.

The averages of the equipment sale data and the regression equations indicate that salvage values tend to drop sharply in the first year, losing over a third of their value. Feller-bunchers lose resale value most rapidly, and loaders retain their values best (Fig. 6). This confirms what one would expect, since use in the woods will wear out equipment faster than use at the landing. Resale values remained high even after the commonly cited life spans for depreciated equipment. They leveled off after about 5 years, at values of 20 to 35 percent of the original sale price. Even equipment that was up to 10 years old maintained a value of about one-quarter to one-third of its original sale price.

The prediction of resale values by this or any other model cannot be exact. Many factors influence the value for a particular piece of equipment. The factors used in the regression equations estimated by this study could not explain all the variation in used equipment prices, as indicated by the modest coefficients of determination. The machine classes used in this analysis were fairly broad, so they included many makes and models that could affect resale values differently. Equipment prices depend on market competition — the needs of buyers and sellers. Prices may vary within a region because of local economic or harvesting conditions. Original equipment may be removed and newer equipment added to a machine, and this may not have been listed in the sale report.

Overall, the models selected here are more accurate than traditional rules-of-thumb and can provide resale values for equipment at various ages. The coefficients of determination and statistical tests indicate that the regression equations are statistically significant predictors of resale values. Increasing the number of machines surveyed, particularly newer machines, would increase the accuracy of the resale value equations. These analyses also should be updated periodically to ensure that economic conditions do not alter the salvage value relationships found in this study.

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History of controlling wood decay with fumigants detailed

In the late 1950s, internal decay of Douglas-fir poles, especially transmission poles, posed a serious threat to their serviceability. A committee of personnel from electric utilities and the Forest Research Laboratory, Oregon State Univ. (OSU), was formed to find a solution to the problem. The committee consisted of Del Brown, Portland General Electric Co.; Floyd Hand, Bonneville Power Administration (BPA); Don Jones, Clark County P.U.D., Washington; Larry Palmer, Pacific Power & Light Co.; and Bob Graham, OSU.

The committee's deliberations led to the investigation of chemicals that might move as a gas through the microscopic openings in wood to halt the advancing fungal front. BPA researchers have reported that initial tests of liquid soil fumigants in sections from decaying poles proved promising in halting the decay, but how long would these gases remain in wood? To answer this question, BPA and OSU researchers fumigated decaying Douglas-fir transmission poles in the Northwest and in New York, with the cooperation of the New York State Electric and Gas Corp. Pete Lindgren, BPA, first applied fumigants to poles in service.

Mal Corden, OSU Dept. of Botany and Plant Pathology, joined the research group and helped develop a wood block test to rapidly evaluate potential fumigants. His staff cultured cores removed from untreated and then fumigant-treated poles, piles, and timbers and identified the fungi. At the peak of the research, they cultured 25,000 cores in one summer.

The results were so promising that pathologist Ted Scheffer was retained to evaluate the research upon his retirement from the USDA Forest Products Lab. His report confirmed the group's findings and he asked to join them. Meanwhile, Bob Zabel and his staff at Syracuse Univ. initiated research on the fumigation of southern pine poles.

Bob Graham retired from OSU's Dept. of Forest Products in 1983, but research to develop effective fumigants that persist in wood for longer than 10 to 15 years will continue under the guidance of Jeff Morrell.

Now used extensively in the United States and Canada, fumigants have retained markets for Douglas-fir poles and have saved billions of dollars annually for electric utilities and their customers. The savings from fumigant-treated timbers in buildings, bridges, and waterfront structures is unknown.

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